9. Grasping the Chaos

Eyewitness testimonies occupy a very prominent place in the history of the Tunguska problem. To begin with they formed the basis of this subject. Without these testimonies, even if some were misquoted by newspaper reporters, Leonid Kulik would probably have never known about the Tunguska event, and it would have been forgotten forever. This could have happened if, for example, the Tunguska space body (TSB) had arrived from the north, where potential eyewitnesses were few and far between and nomadic Evenks in this wilderness had no contacts with newspapers. As for the 30 million leveled trees in the Great Hollow, they would simply have rotted – since nobody would ever have become interested in them.

Obviously, eyewitness testimonies are different from strict instrumental data. Useful information is but a "weak signal" hidden among different "background noises," and the researcher has to devote considerable effort to find this signal. What a pity that in 1908 there was no Prairie net or similar systems of automatic monitoring of bolide activity in the sky! But certainly, Tunguska eyewitness reports should not be ignored when looking for explanations of this phenomenon. As Dr. Vitaly Bronshten wisely noticed, we must reject even "good" theoretical models of the Tunguska event, if these models come into conflict with information obtained from the eyewitnesses. These reports can be considered as a kind of boundary conditions for the "Tunguska theories." If a theoretical model goes beyond these boundaries this means it has nothing to do with the real Tunguska phenomenon.

The researcher should, however, be careful. A judge in a court considering a criminal case does not wave away eyewitness testimonies, but neither are they accepted uncritically. Instead, he or she compares the different testimonies as well as the material traces of an event, filtering out possible eyewitness errors and spurious

V. Rubtsov, *The Tunguska Mystery*, Astronomers' Universe,
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information. And with time, the true picture of the crime may emerge. This is the path that is to be recommended for Tunguska researchers.

Eyewitness reports may be used not only as factual restrictions for Tunguska theories. They can also reveal such sides of the Tunguska event that have not been reflected in its material and instrumental traces – say, the outer appearance of the TSB. And only when all the three types of Tunguska evidence – material, instrumental, and informational – jointly corroborate a theory can the researcher be sure that he or she is building the correct picture of the phenomenon.

Now, what information do we have at present about observations of the flight and explosion of the TSB? Unfortunately, there are no longer any surviving eyewitnesses and therefore we are dealing only with written records of their testimonies. It is no longer possible to correct errors in these texts, nor to supplement them with any additional information. But the number of such accounts is large. The General Catalog of Tunguska eyewitness reports has 920 entries. It is based on materials that were published in newspapers, journals, and monographs, as well as on archival materials and first-hand information collected by members of the Independent Tunguska Exploration Group (ITEG), the Committee on Meteorites (KMET), and the All-Union Astronomical and Geodetical Society (AAGS) in their Siberian expeditions. When the catalog was being prepared for publication, 212 eyewitness reports were removed from it – reports that could not have had anything to do with the TSB. In all likelihood, the eyewitnesses saw other large bolides that flew over central Siberia in different years. But there remained 708 reports directly related to the Tunguska phenomenon. True, not every eyewitness account in the published catalog contains information about the *flight* of the TSB – in some reports, only sounds accompanying its flight are described, or the flash and the sound of the Tunguska explosion, or the post-catastrophic earthquake. Nonetheless, in about 500 accounts the witnesses report the flying body, describing its shape and/or its brightness and/or its direction of flight. Not all testimonies are sufficiently complete; alongside very detailed reports we can find those that say little more than "something did fly." But such accounts are also important. They mean that at the place where the witness resided, the TSB was in fact seen, which can help to determine its flight path.

Various accounts may also differ in their reliability and accuracy of the event. Having grouped reports in different categories and statistically analyzed them, the researcher may eliminate less-reliable and less-accurate accounts. But it would be a mistake to try and rank them in this way *before* analyzing them. Even the worst eyewitness has one essential advantage over the best investigator: he or she was there and the investigator was not. However, attempts to "correct eyewitnesses" were made more than once in the history of the Tunguska problem. Evgeny Krinov, as well as other KMET members, stated repeatedly that many witnesses of the Tunguska phenomenon "had muddled up the points of the horizon." This would have been strange for inhabitants of the taiga. Here is one example.

A. Bulaev of the Siberian city of Krasnoyarsk wrote in his letter to the USSR's Academy of Sciences, dated October 17, 1962: "In 1908 I lived, together with my parents, in the village of Verkhne-Pashinskoe, some 10 km from the town of Yeniseysk. On June 30, my aunt and I visited my grandma Marina who lived nearby. Two windows of her house faced south. While my aunt and grandma were talking, I was looking out of a window. Suddenly I saw a red ball with a fiery broom behind it. The ball was twice as large as the sun, and the broom emitted sparks. They were not that bright and swiftly dispersed in the air. I cried out: 'Look here! Little sun is falling!' All dashed to the window. The fiery ball was already going down behind the local graveyard and then both the ball and the broom vanished. . ."

Having thanked the eyewitness for the interesting information, the scientific worker of KMET, Igor Zotkin, nevertheless noted:

"We already know that the Tunguska meteorite fall was seen near the town of Yeniseysk. Your letter confirms this data. Indeed, at Yeniseysk and other settlements at the mouth of the Angara River the flight of the Tunguska bolide was observed by many people. Unfortunately, there are in your letter some errors as well. Probably, you saw the fiery ball in the east, not in the south. . ."[1]

Of course, during 54 years that passed between the Tunguska event and Bulaev's contact with the KMET people, the eyewitness could have forgotten which point of the horizon had faced the windows of his grandma's house. After examining all eyewitness reports that came from Yeniseysk, this could have become evident.

But if such an examination *starts* from correcting "a priori erroneous" information in these reports, how could we have hoped to obtain from them any objective data about the event? An attorney in a law court will do everything that can be done to make the judge believe in the version of the affair that is favorable for the person being defended, but of course a serious scientist cannot behave in a similar manner.

But all the same, the question of reliability of eyewitness testimonies does deserve attention, and we should consider it in some detail. These accounts were collected in three stages. First, immediately after the event: the questionnaires of Arkady Voznesensky and newspaper articles of July 1908. Then, 15–30 years later: interrogations of local inhabitants by Leonid Kulik, Evgeny Krinov, and Innokenty Suslov in the 1920s to the 1930s. And finally, 55–65 years after the Tunguska catastrophe: special expeditions of the ITEG, KMET, and AAGS. As regards their reliability and completeness, each of these sets of data has its own advantages and drawbacks.

Let's start from the first set of eyewitness accounts, collected in 1908. The Tunguska event had just happened, and therefore neither could it be forgotten nor could the TSB be mistaken for something else. If the gathering of data on the observations of the TSB flight had started immediately, the results obtained would have been comprehensive and precise. Alas, this did not happen, and therefore the information we possess is pretty muddled. Although Voznesensky's questionnaires contain very valuable material, his questions were aimed at getting information about an earthquake. Perhaps, because of that, among 61 answers only 11 mentioned the flight of the TSB. Newspaper articles of the time also deserve attention. Journalists happened to describe the Tunguska event in some detail. But they reported no individual eyewitnesses with their names and addresses. Instead, we find on these old yellowish pages mainly references to some unnamed persons. "Here people saw…," or even "They say that here people saw…" From the famous article by Alexander Adrianov, which had been published in the newspaper *Sibirskaya Zhizn* (*Siberian Life*) and subsequently drew Leonid Kulik's attention to this phenomenon, we can see to what extent this information could become corrupted. But certainly, not all reporters were prone to such fantasies, and even Adrianov himself had probably not invented the whole story. Perhaps it was told to

him by a passenger from the train that had been stopped by its driver when approaching the station of Filimonovo who was frightened by the sounds of the bolide's flight.[2]

The second set of eyewitness reports was accumulated at a time not too distant from the event and more methodically. But the only thing Leonid Kulik longed to know was: where had the meteorite fallen? Its trajectory was for him of secondary importance. For him, a meteorite could only travel in one way – straight to the point where it was doomed to end its life. And being a very goal-oriented person, Kulik simply wished to find out where that point was, in order to dig up the meteorite. As for Evgeny Krinov, he just recorded for his future book *The Tunguska Meteorite* some stories told to him by people in Siberia. Krinov believed that to determine the trajectory of the TSB (from which it would become possible to calculate its orbit in the Solar System), several detailed eyewitness reports would be enough. So why would he have had to accumulate hundreds of such reports? For a "normal" meteorite, Krinov's approach would have been justified, but not for the TSB. The material collected in the 1920s and 1930s, although useful, was not systematic enough to definitely determine the TSB trajectory.

The third group of Tunguska observations emerged somewhat unexpectedly. By the early 1960s the Tunguska researchers considered the collection of new eyewitness reports as rather pointless. Most of the eyewitnesses had already died and those surviving would hardly remember anything useful. Such was the general opinion. The real situation was different. At that time in central Siberia there were still many people who had seen the Tunguska bolide and heard the terrible boom of its explosion. The whole event had been fixed firmly in their memories. This – no exaggeration – discovery was made by Victor Konenkin, a school teacher of physics from Vanavara, the settlement closest to the epicenter of the Tunguska explosion (see Figure 9.1). Konenkin was born and grew up in the village of Preobrazhenka, on the riverside of the Nizhnyaya (Lower) Tunguska River, where in the long winter evenings he heard so often the tales of his older neighbors about the striking event of half a century before.

In 1962, the teacher decided to find out what the enigmatic flying object had looked like and how it had flown. He traveled to dozens of villages on the Lower Tunguska and its tributaries,

FIGURE 9.1. Victor Konenkin, a schoolteacher from Vanavara who has discovered that the flying Tunguska space body had been seen not only to the south from the Great Hollow, but to the east as well, up to 500 km from this site (*Source*: Zhuravlev, V. K., Zigel, F. Y. *The Tunguska Miracle: History of Investigations of the Tunguska Meteorite*. Ekaterinburg: Basko, 1998, p. 124.).

interrogating the surviving eyewitnesses. If the eyewitnesses still lived at the same settlement where they had seen the TSB, Konenkin asked them to come to the place of their observation. They took with them a compass and an angle gauge. The eyewitnesses showed the teacher at which point in the heavenly sphere they had noticed the fiery body for the first time and where it had disappeared. Of course, some eyewitnesses had already forgotten details of their observations, but all of them remembered the flight of the fiery body and also whether it had flown from left to right or from right to left.

Konenkin's investigations enabled him to determine where the TSB had traversed the Lower Tunguska River. The task was accomplished very simply. This part of the river flows almost strictly from south to north, so that eyewitnesses located upstream (farther south) from the place where the TSB was traversing the river saw it flying from right to left, while those downstream (farther north from the intersection) saw the TSB flying from left to right. After processing the data collected, it turned out that the TSB had flown

over the river near the village of Konenkin's Preobrazhenka. And its inhabitants did confirm this, saying that the fiery object had flown directly over their village in 1908.

So a simple method obtained a result that must be correct. But there appears a problem: the village Preobrazhenka is situated at a distance of 350 km from the Tunguska epicenter and *almost directly to the east*. Most previous eyewitness reports were gathered to the *south* of the epicenter – up to a distance of about 1,000 km. How, then, could the TSB have approached the Great Hollow simultaneously from the east and also from the south?

The information collected by Victor Konenkin was so startling that it needed verification. Several expeditions – sent by KMET, ITEG, and AAGS – left for the Lower Tunguska, and they confirmed that Konenkin's data were correct. They also gathered additional eyewitness reports themselves. To the 35 accounts collected by Konenkin, another 150 were added.

Later, Tunguska investigators spread their questioning activities farther east – up to the Lena River. This work lasted until 1972, when it became evident that the "ore" had been mined and no new eyewitnesses could be found. So during several years, about a thousand people who in 1908 had lived eastward from the epicenter of the Tunguska explosion were questioned. There are now available about 550 eyewitness reports from the eastern sector, some 400 of which contain descriptions of the flying TSB.

The third set of observational data proved to be *very* informative. Its number of reports is more than three-fourths of the total, and these accounts were collected very thoroughly. The expedition's researchers were repeatedly using compasses and angle gauges to obtain quantitative data about the TSB path. The only apparent disadvantage of this set of data is its late collecting. The eyewitnesses were interrogated more than half a century after the event, being, at the same time, well familiar with the layout of their landscape.

Incidentally, in 1999 Konenkin's calculations of the TSB trajectory were again checked by the experienced meteor specialist Dr. Vitaly Bronshten. And he confirmed once more that the results were definitely correct. It was over the village of Preobrazhenka – or maybe a couple of kilometers farther south – that the TSB had been moving to the place of its destruction.[3]

Thus, eyewitness reports from the first group (about a hundred accounts dated 1908) are very reliable, since they were fresh, but they contain few specific details. Reports from the second group, about 75 collected in the 1920s and 1930s, are also rather reliable, being relatively fresh. And they contain more details. As for the third group, amassed in the 1960s (550 accounts), these reports, although collected later, are richer in detail.

Now it became possible to form on the basis of this enormous amount of material an authentic picture of the Tunguska phenomenon in general and the TSB in particular. For this, the eyewitness reports had to be statistically analyzed and condensed. If, for example, 90% of eyewitnesses had said that the TSB had looked like a bright white ball flying from the south to the north, this would have meant that we have a reliable and coherent picture of the phenomenon. The remaining 10% of reports describing it differently could have been considered erroneous.

Alas, such an ideal scheme has remained a dream. First, eyewitness reports varied greatly in their contents and terminology, which made their direct comparison difficult. True, some details proved to be consistent. For example, not one of the eyewitnesses reported that the TSB had a dense smoky trail, so typical for iron meteorites. (Such a trail accompanied the fall of the Sikhote-Alin iron meteorite in 1947.) Therefore, the TSB could not be an iron meteorite. But the researchers already knew that, since no pieces of meteoritic iron had been found in the Great Hollow. Much more interesting was to find out what the TSB *could* have been. Or at least, how did it look and behave.

The ITEG founding fathers Victor Zhuravlev and Dmitry Demin, together with Alexey Dmitriev, embarked on a study of the full catalog of the Tunguska eyewitness reports. Dmitriev, being a scientific worker at the Institute of Geology and Geophysics in Novosibirsk, had been for a long time engaged in computer analysis of the descriptions of geological objects made by prospectors. He therefore suggested using the same methods for examining the Tunguska accounts. Each one was dissected according to a formal scheme, and characteristics of the Tunguska phenomenon (time and duration of observations, shape, and color of the flying body, its direction of flight, and so on) were extracted. The resulting

set of formalized information was analyzed with the help of computer programs.[4]

Now, which results have been obtained?

There were three main areas of eyewitness reports (see Figure 9.2). First from the southern sector where the TSB had been seen by inhabitants of settlements situated on the banks of the Angara River, second from the eastern sector (the upper reaches of the Lower Tunguska and Lena rivers), and third from the central area surrounding the epicenter of the Tunguska explosion – up to about 100 km from it. The "southern" observations were mainly collected before World War II, the "eastern" ones in the 1960s, and the "central" observations both

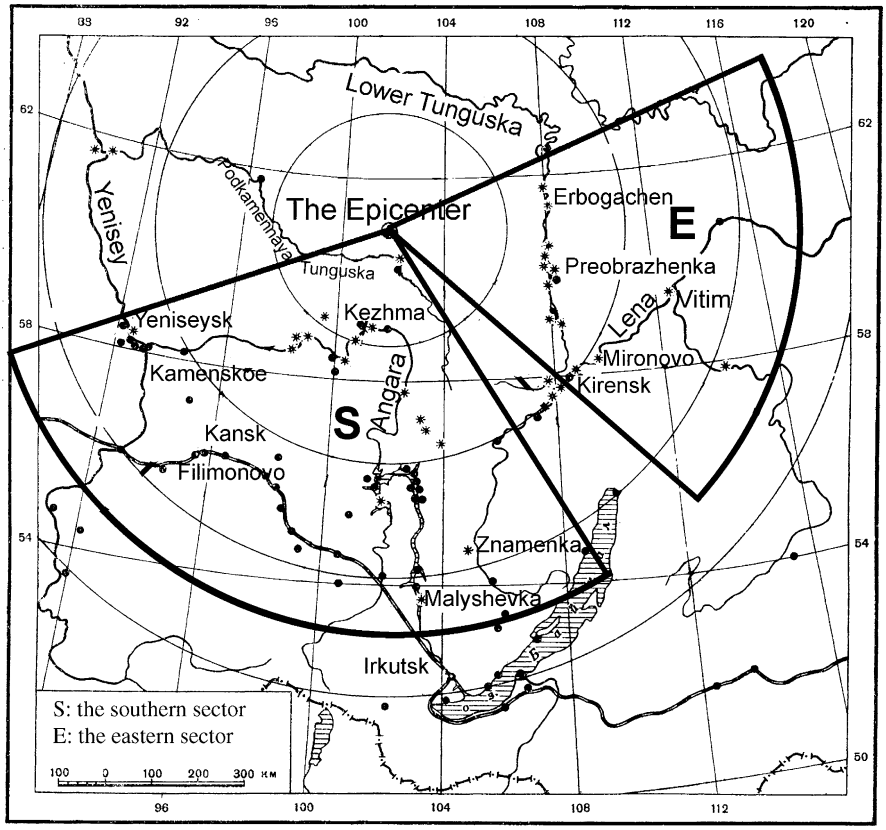

FIGURE 9.2. The southern and eastern sectors, from where came reports of eyewitnesses observing the flight and explosion of the Tunguska "meteorite" (*Based on*: Zotkin, I. T., Trajectory and orbit of the Tunguska meteorite. – *Meteoritika*, Vol. 27, 1966, p. 109.).

before and after World War II. Such a distribution of "observational zones" was understandable: just in the southern and eastern sectors the density of population in 1908 was relatively high, whereas to the north from the epicenter there were no permanent residents at all. But what seemed highly incomprehensible from this work was the radical difference between the images of the TSB built on the basis of the southern and eastern sets of observations. Data obtained inside each sector made it possible to create a statistically reliable and coherent image of the Tunguska phenomenon, but these two images were utterly different.

In the south, the phenomenon (including thunder-like sounds) lasted half an hour or more. The brightness of the TSB was comparable to the Sun. The body looked white or bluish. It had a short tail of the same color, and after its flight there remained in the sky iridescent bands resembling a rainbow and stretching along the trajectory of the body's motion. And it flew from the south to the north.

Take one example. In 1908, political exile T. N. Naumenko had lived in Kezhma some 215 km south-southwest from the epicenter of the explosion. In 1936, when in Moscow, he recalled: "The day was sunny and absolutely clear – not a cloud in the sky; no wind at all; complete silence. I was facing north. At about 8 o'clock the Sun was already quite high in the sky, when there was a hardly audible sound of thunder. It was far away but it increased. There was a weak clap of thunder and I quickly turned to the southeast, towards the Sun. Its rays were being crossed from the right by a broad fiery-white stripe. On the left an elongated cloudy mass was flying to the north. It was even brighter than the stripe – dimmer than the Sun's disk but almost as bright as its rays. A few seconds after the first clap of thunder, there was a second much louder clap. The flying lump was no longer visible, but its tail (the stripe) was now to the left of the Sun's rays. It was getting broader than it was when on the right. Almost immediately there followed a third clap of thunder, so powerful that the earth trembled and a deafening rumble resounded over the boundless Siberian taiga."[5]

Also in Kezhma, a local dweller, A. K. Briukhanov, did not see the flying body but noticed the iridescent trail behind it. "I was dressing after a bath and suddenly heard a loud noise. Half-dressed, I dashed to the street and immediately looked at the sky, since the

noise was coming from above. And what I saw were blue, red, and orange bands running in the sky, as broad as the street. After some time the bands faded, the rumble rang out anew, and the earth quaked. Then the colored bands appeared again and again, after which they went to the north."[6]

But if we look at the eastern TSB observations, we find that the brightness of the flying body was much lower than the Sun (as eyewitnesses emphasized, "one could look at it while not blinking"). Its color was red and the shape was that of a ball or an "artillery shell" with a long tail. Usually eyewitnesses said simply: a "red fiery broom" was flying or a "red sheaf," and it was swiftly moving in the western direction, leaving no trace behind. The duration of this phenomenon (including the "firing" after its flyby) did not exceed a few minutes.

Here is a typical description of the TSB observation from the eastern group. In 1908 Feofan Farkov lived in the settlement of Erbogachen (330 km from the epicenter to the east-northeast, on the right bank of the Lower Tunguska River). "I heard a rumble and looked southward. There was flying in the sky a fiery sheaf. I noticed it when it was already to the southwest from Erbogachen. The fiery sheaf flew from left to right – that is, to the west. Although it was flying swiftly, I had time to make out that the body was elongated, its head darker, and behind the head there was a flame and then a bundle of sparks. After its flight, there remained in the sky no trace. Windows in Erbogachen were rattling. All the people were so frightened and they said: 'Armageddon has come!'"[7]

Now a normal bolide moving through the atmosphere is slowed down by the friction of the air and therefore its temperature and brightness are diminishing. Generally speaking, the TSB had to behave in the same way. That is, its brightness must have lessened and the color must have changed from white to red. In reality, eyewitnesses in Erbogachen (330 km from the epicenter) saw a *red* bolide, whereas those in Kezhma (215 km from the epicenter) saw a *white* one, which is the opposite to what would be expected. Well, perhaps the eyewitnesses might have perceived (or described) the outer appearance and even the color of the Tunguska bolide incorrectly, but at least they could tell us how the bolide moved. So the initial objective of those gathering Tunguska eyewitness reports was very simple. They wished to determine the direction of flight and the slope of the path of the Tunguska "meteorite." This

would have made it possible to find its radiant on the heavenly sphere (that is, the point from which it came to Earth) and then its initial orbit around the Sun. Yet suddenly, the scientists met in this work with serious obstacles. Taken alone, the southern observations of the flying TSB were in good accordance, but the eastern group of eyewitness testimonies brought discord.

Initially, before the "eastern" testimonies came to light, the situation had looked more or less simple. The first attempt to determine the TSB trajectory was made, soon after the Tunguska event, by Dr. Arkady Voznesensky, Director of the Magnetographic and Meteorological Observatory at Irkutsk. Having processed the data he possessed, Voznesensky concluded that the Tunguska meteorite had flown practically from the south to the north, with a small deviation to the east. Subsequently it turned out that Voznesensky's trajectory, being drawn on a map, passed within 70 km of the true Tunguska epicenter – a reasonably good calculation, one must admit. Leonid Kulik, during his meteoritic expedition of 1921–1922, talked with a number of eyewitnesses and was also certain that the Tunguska meteorite must have flown from the south to the north. The noted meteor specialist Igor Astapovich in 1930–1932, during his geophysical expeditions to the Angara River, collected new eyewitness accounts. He afterward processed all materials that were known by that time and came to the same conclusion: the TSB trajectory practically ran from the south to the north, with a very small deviation to the east.

What is more, Astapovich found that in Malyshevka (located some 800 km to the south-southeast from the epicenter) the TSB had flown from right to left, whereas in Znamenka (140 km to the northeast from Malyshevka) it flew from left to right.[8] Consequently, the TSB trajectory must have passed between these settlements. That is, the TSB did come from the south and move almost precisely to the north. But at the same time, it must have passed, according to Konenkin's findings, over the village of Preobrazhenka, which was located 350 km from the epicenter almost directly to the east. That is, the TSB came from the east and moved almost precisely to the west.

Now, what did the Tunguska researchers achieve, having accumulated a whole lot of testimonies of eyewitnesses of the TSB flight in the southern and eastern sectors of the region, and having composed the complete catalog of these accounts and statistically

processed the data? They obtained *two different TSBs*, one of which was relatively slow flying to the Great Hollow from the south, shining with bright white-bluish light, whereas the second one was racing from the east, glowing red. Not bad! Does this mean that two giant bolides flew on very different trajectories to the same final point on the same morning? Not probable, at least if we are dealing with natural bodies from space.

So how do we resolve the paradox that has come from the detailed study of the eyewitness reports?

Well, it seemed reasonable to consider one of the sets of eyewitness testimonies as having nothing to do with the real Tunguska phenomenon. Either the southern or the eastern reports would have had to have been erroneously associated with it. But which? The answer looked obvious. Of course, it was the eastern set of observations that had to be discarded. The southern set is basic. It was collected while the scent was hot – and it was due to these eyewitness reports that Leonid Kulik reached the place of the TSB explosion and found there the enormous area of radially leveled forest. To consider these observations as having no relation to the Tunguska event would have been absurd. Whereas the eastern set, though rich and very systematically accumulated, was gathered more than half a century after the Tunguska explosion. Were it not for Victor Konenkin, these reports would have vanished with time, together with the eyewitnesses, and hardly any researcher would have supposed that they had ever existed. The "eastern testimonies" are excessive; they make a mess of the Tunguska problem instead of helping to solve it. Therefore, it is these reports that should be dropped and forgotten. Let's suppose that they had been due to the flight of another large bolide sometime in the 1920s, 1930s, or 1940s.[9]

This solution might have been accepted by the Tunguska research community. They could even have ignored the fact that the eastern eyewitnesses all point to 1908 as the year of the event – not to any other year or decade. Human memory, you see. But this simple solution ran into a serious obstacle. The most reliable traces of the Tunguska phenomenon are material ones – the area of leveled forest, first of all. And we know that the second Fast's TSB trajectory, determined from the axis of symmetry of this area, does run from the east to the west. Also in the same direction runs the TSB

trajectory determined from the axes of symmetry of the zones of light burn and the thermoluminescent anomaly. These facts do demonstrate that over the Great Hollow the TSB was flying from the east to the west. Consequently, it is the eastern set of eyewitness testimonies that definitely has direct relation to the Tunguska phenomenon.

But here we have a big problem because we have already made sure that the southern set is also directly related to the flight of the TSB. So what about our analysis? It appears that neither the southern nor the eastern set of eyewitness testimonies can be justifiably discarded, yet they each tell different stories. But then, perhaps the TSB made a maneuver? If its flight path was winding, this might explain the drastic contradiction.

The question about possible TSB maneuvers was raised by astronomer Felix Zigel in a paper read at the Sternberg State Astronomical Institute in 1967. By that time Zigel was already aware of Konenkin's findings. He understood that the TSB had flown over the Lower Tunguska River near the village of Preobrazhenka, which is almost directly *east* from the epicenter. But he also knew that the TSB was seen at the village of Kezhma, almost directly *south* from the epicenter. Zigel drew attention to an interesting detail: nobody had seen the flying TSB to the north from Kezhma. Perhaps, having flown over Kezhma, the TSB turned to the east and then to the northwest – moving, so to say, in a zigzag course? In this case, of course, it could not be a natural body; rather, this maneuver seemed to corroborate Kazantsev's starship hypothesis.

In principle, Zigel's idea was reasonable. One maneuvering TSB looked more acceptable than several flying from different directions to the same final point. But the lack of eyewitness reports about the TSB flight between Kezhma and the epicenter could be explained in a simpler way – too sparse a population. Second, no one saw the flying TSB between Kezhma and the Lower Tunguska River. And third (perhaps the most important), when speaking before the leading Soviet astronomers Zigel did not know that Preobrazhenka was not the farthest eastern point where the flying TSB had been observed.

It was in the summer of 1967 that the ITEG-9 expedition, led by Lilia Epiktetova, questioned inhabitants of several villages by the Lena River and discovered that the TSB had flown over this river near the village of Mironovo, at a distance of 500 km southeast of the

epicenter. If Mironovo had been situated farther north from Kezhma, such a maneuver would have looked like a simple zigzag. But Mironovo is situated *farther south* from Kezhma – and therefore, to get there, the TSB would have had to perform a very complicated series of turns.

There was another convincing argument against any maneuver of the "southern" TSB: the precise determination of the direction to the epicenter of the Tunguska explosion, which was made by Arkady Voznesensky from answers to his questionnaires. Of all TSB trajectories calculated by various scientists, it is the trajectory proposed by Voznesensky that deserves our confidence. When calculating it, he did not know where the Tunguska meteorite had ended its flight path. All other researchers (Astapovich, Krinov, Konenkin, Epiktetova) proposed their trajectories when they were well aware of the final point of the trajectory – namely the Southern swamp. So their considerations somewhat resembled forcing the data to fit the known answer. As for Arkady Voznesensky in 1908, he did not know of the Southern swamp's existence, yet his calculated trajectory approached this swamp (and therefore, the Tunguska epicenter) to an accuracy of 70 km. But then, the "southern" TSB must have flown straight to the Southern swamp, not making any maneuvers.

At the same time, materials collected in the eastern sector appear to testify that the "eastern" space body did maneuver. Konenkin not only found that the TSB had flown above the Lower Tunguska River and Preobrazhenka but also determined that it had flown from the east-southeast to the west-northwest. But moving in that direction the TSB could not have arrived at the Southern swamp. Instead it would have missed by a hundred kilometers. Also, Mironovo, Preobrazhenka, and the epicenter do not lie along a straight line. To fly over these three points, the TSB must have traveled along a distinct arc.

Incidentally, there are five "eastern" reports in which eyewitnesses describe how the flying body changed its direction of flight. Here, for example, is the testimony of V. K. Penigin, who was born in 1893. His point of observation was the village of Kondrashino on the right bank of the Lena River (some 500 km from the epicenter to the east-southeast):

"Then I was a boy and helped to bring manure to the fields. We were upstream from the village. The fiery flying body was well seen. It resembled an airplane without wings, or a flying sheaf. It was as long as an airplane and flew as high, but more swiftly. The body was as red as fire or a tomato. It was flying horizontally, not descending, and passed in front of the cliff of Tsimbaly, at about two-thirds of its height. Then the body covered some 2 km more and made a sharp turn to the right, at a very acute angle."[10]

Possible explanations of such strange behavior of the TSB will be considered in the next chapter. Here we would only like to note that the simplest hypothesis – that this was an alien spaceship – is not the only acceptable answer. In fact, under certain conditions even an ordinary piece of stone from space could have changed its direction of flight.[11] Though here is another problem. The most distant point of observation of the TSB mentioned in the early eyewitness reports (that is, the most trustworthy reports) is the village of Malyshevka. It is located about 800 km from the epicenter to the south-southeast. It was just a few days after the Tunguska event that a member of Arkady Voznesensky's earthquake monitoring network informed him that the bolide had been seen there. Somewhat later (in 1921) Leonid Kulik found that the TSB had also been observed on the bank of the Yenisey River, some 960 km to the southwest from the epicenter.

Therefore, having entered Earth's atmosphere at a great distance from the point of its disintegration, the TSB covered about 1,000 km, flying, naturally enough, in a flat path. But all "ballistic models" of the Tunguska event require a steep trajectory near the epicenter.

How can we resolve this contradiction? Dr. Vitaly Bronshten assumed that the slope of the TSB path varied. For the most part the TSB was moving at an acute angle to Earth's surface, but near the Great Hollow, at an altitude of 30 km, it made a sharp turn down, with the angle increasing approximately from 10° to 40°. This could have happened if, due to the burning of the TSB as it rushed through the atmosphere, its shape changed and it began to resemble a *Soyuz* or an *Apollo* space capsule turned upside down. Then the aerodynamic force would have acted downward. (Such a space capsule is shaped like a truncated cone with a convex base. When normally reentering the atmosphere, the base is beneath and the aerodynamic force acts

upward, making it possible for the spacecraft to fly in a flat trajectory.) The idea was attractive, since it allowed reconciling the seemingly incompatible parameters of the TSB trajectory at the beginning and in the end of its flight.

This solution led, however, to another contradiction – this time with hypersonics and the laws of the strength of materials. As Dr. Andrey Zlobin, chief of a department of the Central Institute of Aircraft Engine-Building in Moscow, noted: the crucial factors in Bronshten's model were the strength of the TSB material and the g loading (that is, Earth's gravitational effect plus the forces of acceleration during this maneuver). For comparison, the Russian fighter aircraft Sukhoi Su-37, built from special alloys and composite materials and having superb strength characteristics, may sustain up to 10 g loading. But the icy core of a hypothetical Tunguska comet, with a mass of about one million tons and flying at a velocity of 30 km/s,[12] would have changed its trajectory at the cost of aerodynamic forces for about 30° – when descending from an altitude of 30 km to an altitude of 8 km. And it would have done this in a couple of seconds. In this case, the g loading would have exceeded the normal terrestrial gravitation by *several hundred* times. Would the comet core have sustained this? Definitely not. "If you do not agree with this conclusion," remarks Dr. Zlobin, "it means you have made the epochal discovery: that supersonic aircraft may be built from ice!"[13]

In other words, even if a fragile cometary core had reached the altitude of 30 km, its attempt to make a sharp turn down would have immediately destroyed it. Meanwhile, it is well known (and well substantiated) that the TSB exploded at an altitude of 6–8 km. One could add that such a maneuver would have been quite as dangerous for a stony meteorite. So stone also is not a good construction material for supersonic aircraft.

By the way, there is in the Tunguska reports a strange detail: the eyewitnesses constantly say that they heard the sounds first and only then they saw the flying body. "This peculiarity was noticed by many independent witnesses," wrote Evgeny Krinov.[14] For a meteorite, as well as for any other material object flying at a supersonic velocity, such a sequence of events is impossible. Nobody could have heard the sound of its coming before seeing the body itself, because the speed of light is far greater than the speed of sound. So, Krinov said in his book:

"The eyewitness made a mistake. It was the other way round: he saw the flying object and then heard the sound." Yet when the "heavenly boom" rang out, some eyewitnesses were in their houses, having no intention of leaving them. Had they not heard the strange "clap of thunder," they would have remained inside. Therefore, the time interval between the initial sound and the appearance of the fiery body was large enough for them to come out and see the flying object.

Whether or not it would be possible to explain this strange phenomenon by referring to the so-called electrophonic sounds is still not clear. Electrophonic sounds (hissing, crackling, whistling) can accompany the flight of some (though far from all) large bolides. Initially, this was noted in 1719 by the famous British astronomer Edmund Halley in accounts of eyewitnesses of a huge bolide that had flown over England. However, he could not accept the physical reality of such sounds and decided that this was a purely psychological effect. During the following 200 years this opinion dominated. Probably, the first scientist who dared to reject it was the astronomer and Tunguska investigator Professor Igor Astapovich in 1925. The very term "electrophonic sounds" was somewhat later coined by Professor Pyotr Dravert (1879–1945), living in Omsk and also studying the Tunguska problem. (By the way, Dravert was a descendant of an officer from the army of the Emperor Napoleon Bonaparte, who had been captured in Russia in 1812 and never returned to France. In 1921–1922 Pyotr Dravert took part, together with Leonid Kulik, in the first meteoritic expedition through European Russia and Siberia.)

The nature and origin of these sounds are still vague, but the most popular theory, developed by the Australian astronomer Colin Keay in 1980, holds that such bolides are generating radio waves of very low frequencies, which, in one way or another, can be perceived by some people as audible sounds. However, the mechanism of this means of perception remains enigmatic.

Naturally, since radio waves move at the speed of light, electrophonic sounds generated by bolides would move far faster than the bolides themselves. However, they cannot be very loud – nothing approaching the sound of thunder. Usually electrophonic sounds are very soft, being described by witnesses as hissing or humming. In the above-cited observation of T. Naumenko, the first "clap of thunder" definitely preceded the appearance of the fiery body.

Thunder, roar, cannonade, firing – these are the words that were used most frequently – in three quarters of all accounts – by Tunguska witnesses describing sounds accompanying the flight of the TSB.

Perhaps this is how they perceived the ballistic shock wave produced by the TSB flying at a supersonic speed. It was strong to generate acoustic waves powerful enough to frighten people and even to perturb the water in the Angara River, but not so strong as to cause destruction. For example, in 1938 Leonid Kulik talked with D. F. Briukhanov who, in 1908, had lived not far from Kezhma. "I was plowing a field, recalled Briukhanov, and had just sat down near my wooden plow to have breakfast when heavy blows occurred – like the firing of pieces of ordnance. My horse fell on his knees. Above the forest in the north appeared a flame. I thought that some enemies were shooting. . . Then I saw firs bend down and decided that a hurricane had started. So I grasped my wooden plow with both hands not to let it be carried away. The wind was so strong that it blew soil from the field. And then this hurricane drove a large wave on the Angara. I saw all this very well since my field was on a hill."[15]

Of course, the ballistic shock wave could not have preceded the approach of the bolide itself. But neither have thunder-like electrophonic sounds been reported before. It is no mere chance that the catalog of electrophonic bolides that were observed over our planet between 1683 and 1984, compiled by Dr. Vitaly Bronshten and two colleagues, does not contain the Tunguska meteorite entry.[16] Dr. Bronshten, being a true specialist both in the Tunguska problem and in the problem of the electrophonic sounds, understood perfectly that the electrophonic explanation of the Tunguska thundery sounds was not tenable. So this enigma remains unsolved.

Needless to say, impressions of those eyewitnesses who were in the central area of the Tunguska explosion differed considerably from the impressions of distant eyewitnesses. The Evenks who were then still sleeping in their *chums* could not see the approaching space body, but they heard in a doze the noise accompanying its coming, to be awakened by the Tunguska explosion itself – or even, according to some eyewitness accounts, by a series of explosions. And not only was it the boom that awoke them but also the blast

wave that brought the *chums* down and threw them up into the air, scattering their suede covers and stunning their inhabitants.

In particular, the brothers Chuchancha and Chekaren, being young and healthy men, having crawled out from under the remains of their *chum* and standing on the bank of the Avarkitta River (some 30 km from the epicenter), swiftly gathered their wits and began to look around. They remembered the sequence of events very well. That morning they were woken by a few tremors, whistling, and a loud sound of the wind. Having gotten out from their sleeping bags, the brothers heard a "very great clap of thunder" and saw trees falling, their pine needles burning. After this they felt three more powerful bursts accompanied by bright flashes in the sky, and then a fifth burst at a great distance, farther north.[17] A fairly detailed and dispassionate description of a terrible event testified that Chuchancha and Chekaren had maintained their self-possession.

But older Evenks were simply stupefied and bewildered and did not realize what was happening. For example, the *chum* of the Evenks Ivan and Akulina stood at the mouth of the Diliushma River, some 35 km from the epicenter. Akulina told the ethnographer Innokenty Suslov about her experience in the following words:

> We were three in our *chum* – I with my husband Ivan, and the old man named Vasily, son of Okhchen. Suddenly, somebody pushed our *chum* violently. I was frightened, gave a cry, woke Ivan, and we began to get out of our sleeping-bag. Now we saw Vasily getting out as well. Hardly had I and Ivan got out and stood up when somebody pushed violently our *chum* once again, and we fell to the ground. Old Vasily dropped on us as well, as if somebody had flung him. There was a noise all around us, somebody thundered and banged at the *elliun* (the skins covering a *chum*). Suddenly it became very light, a bright sun shone at us, a strong wind blew at us. Then it was as if somebody was shooting, like the ice breaks in the winter on the Katanga River, and immediately after that the *Uchir* dancer swooped down, seized the *elliun*, turned it, twirled it, and carried it off – somewhere. Only the *diukcha* (the *chum's* framework, consisting of 30 poles) has remained at its place. I was frightened to death and became *bucho* (lost consciousness)...[18]

When she regained consciousness Akulina did not recognize her surroundings. Some trees lay on the ground; others stood without branches or without leaves. A box with plates and dishes was lying at a distance. It was open, and many cups had been broken. Fox pelts, squirrel skins, and ermine were hanging scorched on the twigs of larches. Dry trunks, branches, and deer moss were burning on the ground. Akulina's husband Ivan was wounded: he had been blasted away from the *chum* for about 40 meters and his arm was broken. Akulina and the men moved toward another *chum* of theirs by the Dilyushma River. But both this *chum* and a *labaz*, in which food and fishing nets had been stored, had also been destroyed by the fire, and they had to move on toward the Chamba River.

"When we reached it," she said, "we were already very weak. And we saw around us a miracle, a terrible miracle. The forest was not our forest. I have never seen such a forest in my life. It was so unfamiliar. We had had here a dense forest, a dark forest, an old forest. And now there was in many places no forest at all. On the mountains all the trees were lying down and it was light; one could see far away. And it was impossible to go by the mountains through the bogs because some trees were standing there, others were down, still others were bent, and some trees had fallen one upon another. Many trees were burnt and smoking."[19]

It's hardly surprising that frightened people who were so close to the epicenter of a 50-Mt explosion first of all tried to escape and paid little attention to what was happening in the sky. Rather, it is remarkable that not counting the deaths of the many deer belonging to the Evenks, there were no human casualties during the Tunguska catastrophe (apart from the old Evenk Lurbuman, who after the explosion sent his son Ulkigo to find out what had happened, and having heard his report about the huge scale of devastation "became scared to death and died").[20]

Nevertheless, one of the "central" eyewitnesses did see the flying TSB, even though it was flying, so to say, in a wrong direction at a wrong time. Ivan Aksenov, an elderly Evenk man, was one of the people who were questioned by the teacher Victor Konenkin during his trips to the upper reaches of the Lower Tunguska River. Before 1917 he had been a Tungus shaman, a profession strongly disapproved of by the Soviet regime. So, after the Revolution he had to hide for many years in the taiga. Even many years later he had little

liking for anything official – even for meteoritic expeditions sent from Moscow. But toward Konenkin the former shaman felt trust – perhaps because the teacher himself was half-Evenk – so he told him about his experience.

In 1908 Aksenov was 24 years old. That June morning, he was hunting near the mouth of a tributary of the Chamba River, some 25 km to the south-southeast from the catastrophe epicenter. Having shot an elk, he began to flay the carcass when suddenly all around "became red." Aksenov took fright, threw up his head – and at this moment "there was a blow." For some time he lost consciousness. "As I came to myself," recalled Aksenov, "I saw everything was falling around me, burning. I am lifting up my head and see devil's flying. The devil itself was like a billet, light color, two eyes in front, fire behind. I was frightened and I prayed, not to the heathen god but to Jesus Christ and the Virgin Mary. After some time praying I recovered: everything was clear. I went back to the mouth of the Yakukta where the nomad camp was. It was in the afternoon that I came there. . ."[21] The "devil," according to the old shaman, was going faster than airplanes now do. While flying it was saying "troo-troo" (not loud) and its direction of flight was down the Chamba, that is, north to south.

Whether or not Aksenov's story deserves to be taken seriously is a disputable question. On the one hand, both his observation of a flying body *after* the Tunguska explosion and the reported direction of its flight – from the north to the south – provoke natural doubts. But on the other hand, when rejecting what seems to be impossible, the researcher takes a risk of throwing out the baby with the bathwater. Statistical analysis of eyewitness reports is certainly a good and necessary thing, but information obtained from the sole eyewitness who was lucky enough to find himself in the right place at the right time can outweigh a number of reports from less well-situated witnesses. And taking into consideration that the Tunguska catastrophe could have involved more than one body, we could probably accept Ivan Aksenov's story with some degree of trust, if not with unqualified reliance. As for the direction of flight of Aksenov's "devil," we can safely suppose that having survived the Tunguska explosion the eyewitness confused the points of the horizon, and the body did in fact fly from the east to the west. "Down the Chamba" is not that precise, since the river meanders.

Incidentally, even though it is usually thought that there were no eyewitnesses north from the epicenter of the Tunguska explosion, this is not so. As a matter of fact there was one witness who lived far from the Great Hollow. And although he did not see anything, he did hear something. This was ascertained by Ivan Suvorov – a Russian folklorist and writer, who from 1934 to 1965 led a nomad's life in Evenkya and Taymyr Peninsula, recording and translating into Russian legends of northern peoples. In May 1941, when in the upper reaches of the Khatanga River (which flows into the Laptev Sea of the Arctic Ocean) he met Christopher Chardu, a Yakut who in 1908 lived at the trading station of Essey, a distance of 850 km from Tunguska and directly to the north.

Chardu described to Suvorov his impressions from June 30. "The morning was very sunny. We were still sleeping. Suddenly some distant rumble rang out – again and again... And the wind sprang up over the tundra. I awoke and thrust out my head from under the blanket. Now I see that someone is lifting the *chum*. Not once but many times. So I swiftly ran out from the *chum*. There was nobody outside, but the wind was bending bushes to the ground... I was frightened and wondered what could it mean? Probably, Domogor [the heavenly tsar] was furious..."[22]

Of course, if the Tunguska phenomenon was confined to the arrival of a large meteorite and its explosion over the Southern swamp, there could have been no "distant rumbles" and "wind" 850 km to the north from the epicenter.

In general, the eyewitness accounts convincingly demonstrate that the details of catastrophe at Tunguska were more intricate than is usually supposed. In this respect, they supplement well the sets of material traces of this event – both "large" and "small." When analyzing these traces, researchers also begin to realize that past scenarios have proved unable to explain all the data. When we process the eyewitness reports, we obtain, instead of an unambiguous picture of a space body arriving from a definite direction, either two bodies flying in different trajectories or one body performing various maneuvers – or a combination of these.

Krinov's references to the "low reliability" of eyewitness reports and the inability of chance observers to determine even the main points of the horizon, to say nothing about the direction of flight of a bolide, do not sound convincing. Say the trajectory of

the Sikhote-Alin meteorite was determined from the eyewitness accounts quite unambiguously, and no "dissimilar images" arose.[23] Yes, in this case the testimonies were collected soon after the meteorite fall and very systematically – but the scales of the Sikhote-Alin and Tunguska phenomena did also differ radically. Inhabitants of the Tunguska region remembered well the TSB flight and explosion even tens of years after the event, so very impressive had it been.

Certainly, overestimating the significance of eyewitness reports would be as wrong as underestimating them. Albert Einstein liked to say that correct physical theories cannot be directly inferred from experience. Actually, scientists invent their basic principles in a purely intuitive way, and then logically deduce consequences that can be empirically verified. And only these consequences are checked against the empirical facts. Of course, by "empirical facts" the great physicist meant results of properly performed physical experiments. But if it is difficult to create a good theory starting from data obtained in a laboratory, it is still more difficult to do the same from information where the signal is hardly more intense than the background noise. "Deep intuition" of the researcher is for this process no less important than "strict logic." Thus, attempts to "invent" unconventional theoretical models of the Tunguska phenomenon are in themselves far from blameworthy; yet the scientist should constantly compare theoretical schemes he or she is building with the real knowledge of the circumstances and consequences of the Tunguska catastrophe. To what extent the "Tunguska theories" developed for the last 100 years correspond to this knowledge, we will see in the next chapter.

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